Distributed Robotics

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DARPATech 99

Distributed Robotics

MTO

The average rat can:

- Wriggle through a hole no larger than a quarter
- Scale a brick wall as though it had rungs
- Swim half a mile and tread water for three days
- Gnaw through lead pipes and cinder blocks with chisel teeth that exert 24,000 lbs. per square inch
- Survive being flushed down a toilet and enter buildings by the same route
- Plummet five stories to the ground and scurry off unharmed
- Multiply so rapidly that a pair could have 15,000 descendents in a year's life span*

*It is not anticipated that this goal will be met by the DARPA program.

National Geographic July 1977

Distributed Robotics

Develop

Small robots (less than 5 cm)

Using

Novel integrated small system design techniques

For

Application in military missions

Distributed Robotics

Challenges:

- Non-linear scaling laws
- Mobility innovation
- Small system integration
- Interface of micro and meso-scale technologies to the real world
- Energy constrained environments
- Multi-robot control strategies
- User interfaces

Distributed Robotics

Current Projects

Carnegie Mellon University
Case Western Reserve University
Caltech
University of Minnesota
Northwestern University
UCLA
North Carolina State University
Duke University
Xerox PARC
University of Michigan
Michigan State University
Sandia National Laboratory
USC/ISI

Distributed Robotics

- 40 mm diameter robot
- Includes MEMS chemical sensor, MEMS vibrational device and video camera

- Robot rolls and/or jumps up to 1 meter
- Can be shot from M203 or thrown from larger robot
- Enter building (through window)
- Locate chemical (gas)
- Locate vibration source
- Locate people

Distributed Robotics

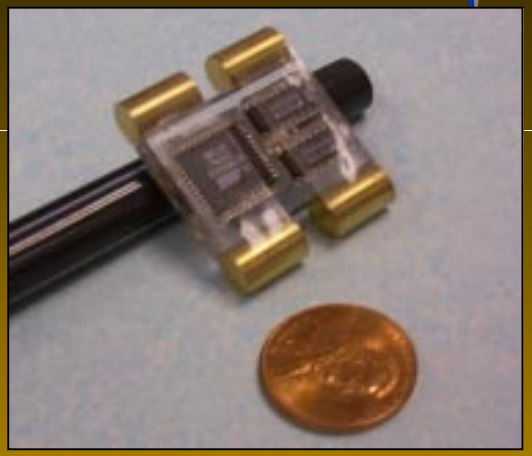
- Small intelligent robot appx 1 cubic inch
- Integrated system with chem-resistor/humidity sensor, RF communications, covert design
- Distributed/decentralized algorithms

-Simple individual algorithms with sophisticated collective behavior/ processing

-Physically distributed memory

-Inherent parallel processing

-Time-spatial correlation



Microcrawler

Distributed Robotics

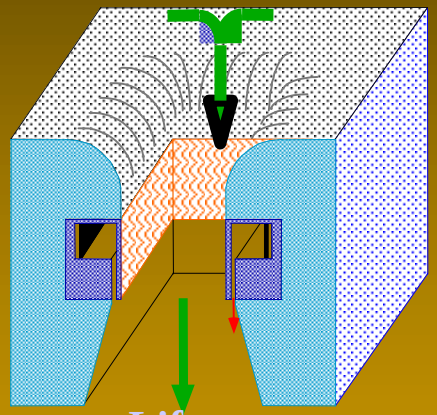
- Inch worm design
- Suction cups with micro-pumps for locomotion
- Climbs glass or other smooth surfaces
- Camera in suction cup
- Radio
- Building surveillance mission

Distributed Robotics

Flying Silicon

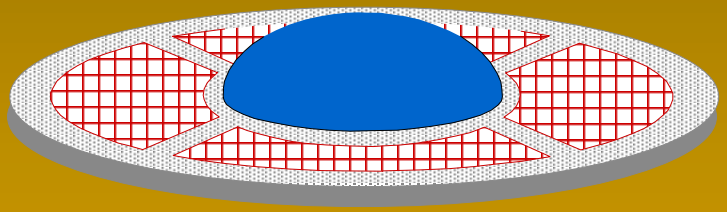
MTO

Air Flow



Acoustic Ejector

Helmholtz Resonator



Micro Air Platform

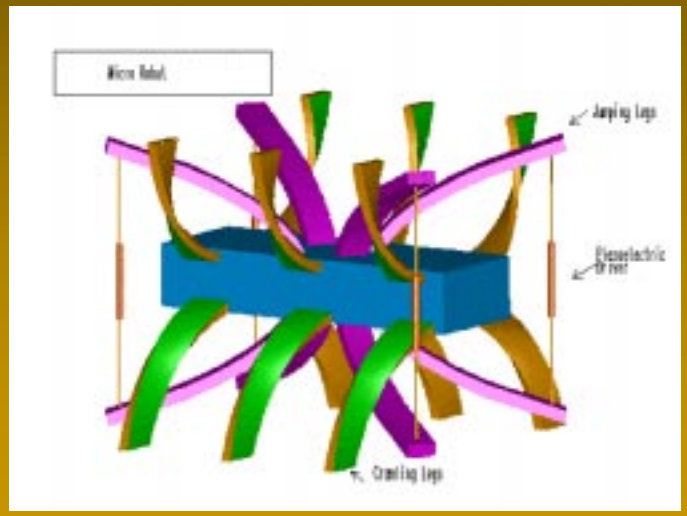
University of Michigan

Distributed Robotics

Simple jumping robot based on a single actuator
Pneumatic "jumper" + positioning legs

Miniature control module including:

-RF range finder for simple location detection
-Magnetic compass
-Charge pump PZT control circuit
-Microcontroller



Distributed Robotics

- Large scale integration of miniaturized components
- Robust distributed control
- Modular locomotion/ application strategies
- Reconfiguration planning

Spider

Dodecahedron

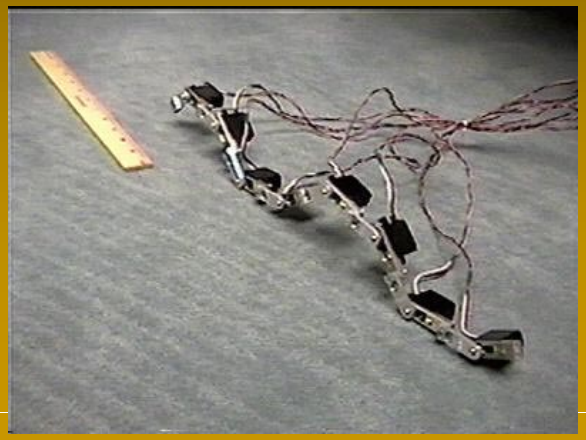
Xerox PARC

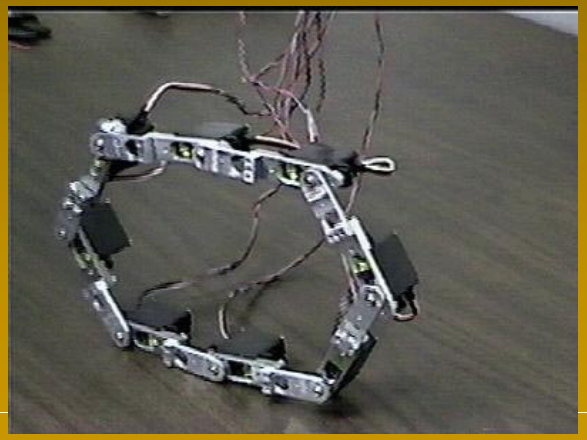
Distributed Robotics

Configurable Robots

- Modular construction
- Sensors, camera, communication
- Reconfigurable

Hexapod





Distributed Robotics

Aquatic MicroHunters track a signal in 3D to its source:

Signals can be any vector field:

- EM fields, including earth's magnetic field
- acoustic fields
- pressure gradient (*e.g.*, depth in water column)
- light

MicroHunters characteristics:

- extremely simple
- can be very small (work at MEMS scales)
- few, miniature components
- few moving parts
- robust (can use low-grade signals, can survive damage)

Distributed Robotics

New BAA will be issued in August 1999

- Novel miniature robots
- Integrated microsystems that move
- Collaborative robots
- Mission specific applications